

Geographic Information System as a contribution to the use of rock powder from the Serra Geral formation in areas of wine geographical indication in Brazil

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Abstract

Brazilian areas of wine geographical indication seek for the sustainable development of their production. The use of rock powder as well as stonemeal practices may contribute to the remineralization of soils and plant nutrition, which can add value to the final produce. However, the use of stonemeal is still incipient in these wine producing regions. Possible reasons for this may include a lack of information regarding the identification of sources of these materials for stonemeal, as well as, the distance of the sources to the farms. The research institution *Embrapa Uva e Vinho* (Embrapa Grape and Wine) has a detailed survey of areas of wine geographical indication in places such as: *Vale dos Vinhedos*, *Monte Belo*, *Pinto Bandeira*, *Altos Montes* and *Farroupilha*, which are all located in the wine region of *Serra Gaúcha* in Rio Grande do Sul state. The research company Geological Survey of Brazil (CPRM) has also done an extensive survey of agromineral sources in several lithotypes of *Serra Geral* formation in Rio Grande do Sul state, identifying materials that best provide nutrients for the plants. In the substrate of the wine region of *Serra Gaúcha*, there are rocks classified as *Fácies Caxias* and *Gramado da Formação Serra Geral*, which have variations along the spills.

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A geographic information system was built with the purpose of creating a geo-referenced database of wine production, including source areas of stonemeal material, and also establishing the distances to the vineyards. Geoprocessing techniques were applied by combining the above mentioned attributes and using the free software gvSIG. The area of geographical indication *Altos Montes*, located in the cities of Flores da Cunha and Nova Pádua, Rio Grande do Sul state, was studied in order to determine more favorable areas for obtaining rock powder for wine farm production.

Keywords: stonemeal, sustainable viticulture, GIS.

Introdução

The Brazilian viticulture industry has been improving its qualifications to compete in domestic and international markets, and the geotechnologies are tools that support the establishment of geographic indications (GI) for fine wine production. One of these practices is to use rock powder – stonemeal in partial or total replacement of chemical fertilizers. Stonemeal practices may contribute to soil remineralization and plant nutrition, which can add value to the final produce.

The geographical indications for fine wines in Brazil seek to meet criteria that lead to certification (labeling), and among them environment preservation and sustainable development of production add value to the final product in the market. The GI that are getting organized and improving its qualifications in the viticulture region of *Região Vitivinícola Serra Gaúcha (RVSG)* are located in the northeastern of Rio Grande do Sul state and correspond to five GI areas: *Vale dos Vinhedos*, *Monte Belo*, *Pinto Bandeira*, *Altos Montes* and *Farroupilha* (Figure 1).

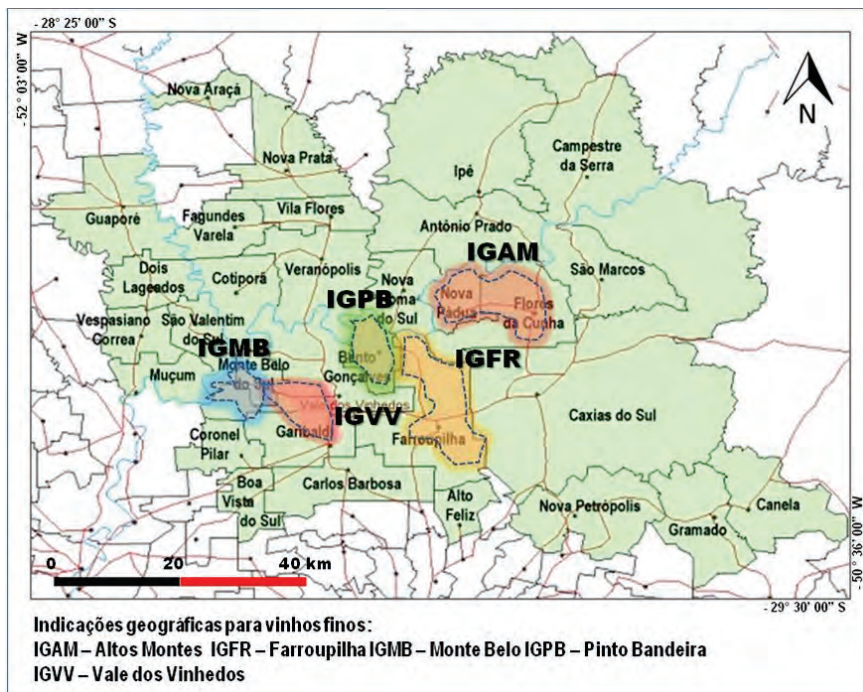


Figura 1. Location of fine wines geographical indications in the viticulture region of “Serra Gaúcha” (Source: Embrapa Uva e Vinho, <https://www.embrapa.br/uva-e-vinho>).

Volcanic rocks have a well known potential in the world as soil remineralizers, and zeolites have the function to fixate nitrogen (macronutrients) among other important cations for plants. The viability of stonemeal implies the close proximity between sources and cultivation areas, so the production expenses are not increased due to processing, transport or other costs of rock powder. This creates an advantage when compared to chemical fertilizers, given that its raw materials, in Brazil's case, need to be imported- making the country largely dependent on foreign markets.

Stonemeal practices are still preliminary in the grape producing areas in Brazil, possibly due to unfamiliarity with its use, lack of identified sources, and analysis of transportation logistics.



The zeolites occur very often in the Serra Geral formation, with the mineralized amygdaloidal basalts being common to many types of zeolites. Despite the lack of commercial quarries in Brazil, the basalts of Serra Geral formation have an undoubted potential as sources for natural zeolites prospection. These minerals have high cationic exchange capacity, which favors nutrient and water retention in the soil, emphasizing the nitrogen compounds fixation, which are highly volatile.

Studies involving spectroradiometry that are integrated with tests of fertility and petrographic analyses on amethyst mining waste had positive results for phosphorus and other nutrients, indicating the possibility of mining waste being employed in agriculture in the region of Alto Uruguai, Rio Grande do Sul state (Bergmann et al 2009). The geographic information system can facilitate vineyard mapping, locating the sources of rock powder, as well as analyzing the distances between them and the vineyards, which categorizes the viability of their use. The general aim of this study was to test the use of GIS to integrate geological data with data on the occurrence of sources of rock powder in the GI's, in order to facilitate the use of rock powder in the viticulture region of Serra Gaúcha.

Materials and Method

Detailed survey data from *Embrapa Uva e Vinho* (Embrapa Grape and Wine) were used regarding the wine-growing area of the geographical indications of *Vale dos Vinhedos*, *Monte Belo* and *Pinto Bandeira*, in the form of polygons related to the table of georeferenced data. A geological map 1:750.000 (CPRM 2008), as well as the geological studies of the GIs (Hoff et al 2007) were used as a basis for field studies. These studies included highway profiles, visits to quarries and to dam construction sites in order to verify the availability of materials such as thin rock powder and mining waste that can be sources of agrominerals.

The spectroradiometer equipment POSAM (CPRM) and Fielspec (Embrapa) were used in order to perform the spectroradiometric analysis. POSAM made it possible to identify hydrothermal alternation minerals, especially the zeolites in SWIR band. Fieldspec allowed for the identification of features like diagnostic absorption bands of minerals in the rest of the electromagnetic spectrum on the bands of multi and hyperspectral orbital images, allowing future digital processing of images.

The GIS analysis used the spatial join tool of the free software gvSIG (GVA, 2012), which allows the association of attributes of two distinct vector themes from a common reference. This association enables the calculation of linear distances between polygons that represent the vineyards and the identified sources for potential use of rock powder. These distances were further categorized into class intervals and spatially.

Results:

The region RVSG has a landscape of plateaus cut by valleys embedded in broad lines of volcanic rock faults and fractures of Serra Geral formation (CPRM, 2008). According to IBGE (2003), in the areas of geographical indications for fine wines in the RVSG, there are two geomorphological units (GU). In the upper portions of the topography the GU is called *Planalto dos Campos Gerais*, and is characterized by a relief varying from gentle hills to flat landscapes. In the lower portions, with slopes and valley areas, the GU is called *Serra Geral*, and is characterized by a pronounced and rugged relief with steep slopes in the Rio das Antas Valley.

The rocks found in the GI mentioned belong to two lithotypes of Serra Geral formation, and they are characterized by the *Fácies Caxias* and *Fácies Gramado* (CPRM 2008). The *Fácies Caxias* occur in the upper portions of the relief and are characterized by having rhyolites, rhyodacites and dacites minerals. The portions located in the land with lower dimensions, such as those close to the Rio das Antas Valley, have basalts from the *Fácies Gramado*. Figure 2 shows the geology of Serra Gaúcha viticulture region and the geographical indications for fine wines. There are two sites that can supply vineyards with mining waste of acid volcanic rocks. The first is the *Pedreira da Concrsul* quarry in the city of Bento Gonçalves, and the second is the *Marrecas* dam belonging to the town of Caxias do Sul. Another source of rock powders are the basalts that have zeolites, which occur in the sediments of reservoirs, such as in the small power station of *Palanquinho* operated by the company *Empresa Serrana Energética*, and the *14 de Julho* hydroelectric plant operated by CERAN.

This study compared the spectral behavior of the potential sources, analyzing acid to intermediate rocks of *Fácies Caxias* and alkaline rocks of *Fácies Gramado*, as shown in Figure 3. This is in accordance with Hoff et al (2007), who pointed spectral differences between acid and alkaline volcanic rocks in the region of *Pinto Bandeira* (RS).

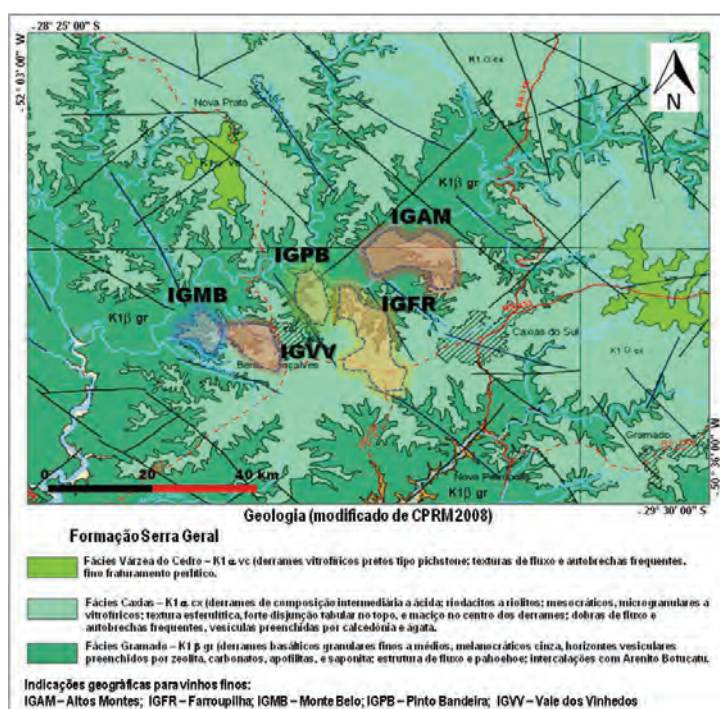


Figure 2. Geology of the Serra Gaúcha viticulture region .

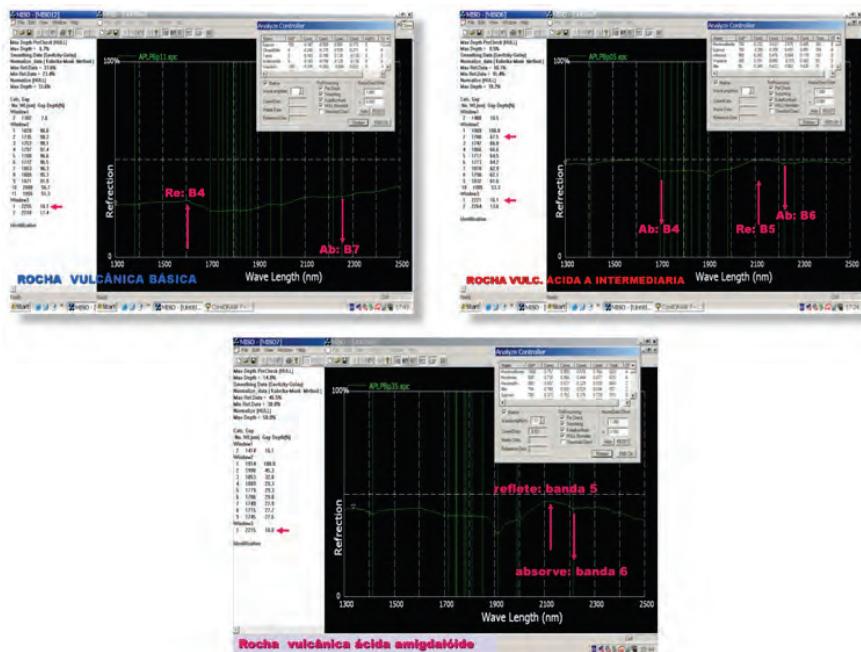


Figure 3. Spectral behavior of rocks from Serra Geral formation, the spectral analysis showed the occurrence of minerals like gypsum, wairauite, anhydrite, montmorillonite, mordenite and heulandite in Bento Gonçalves, RS.

In the of Altos Montes there are vineyards along an extension of approximately 1,700 hectares randomly distributed around the cities of Flores da Cunha and Nova Pádua. Four potential sources of materials for stonemeal were analyzed. With this in mind, the distances to transport these materials from the sources to the vineyard areas were calculated and categorized (Figures 4 and 5).

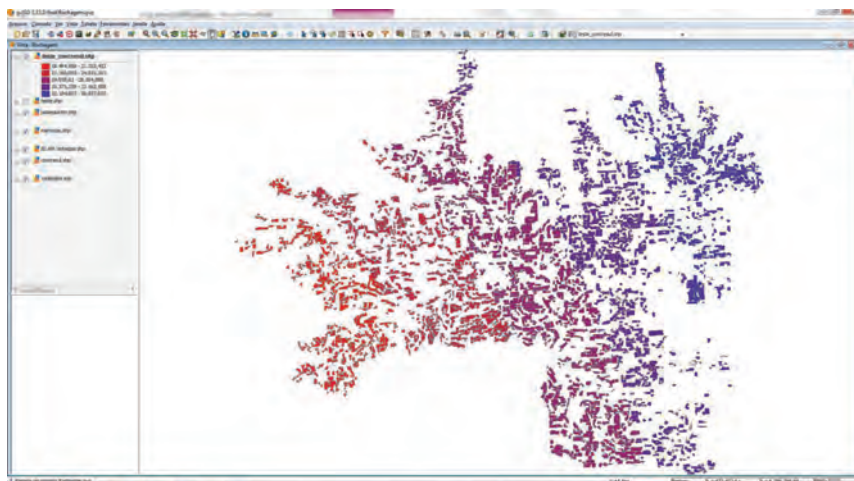


Figure 4. Analysis of the distance from the potential sources of rock powders, departing from the Concrsul quarry in Bento Gonçalves and going to the GI vineyards in Altos Montes.

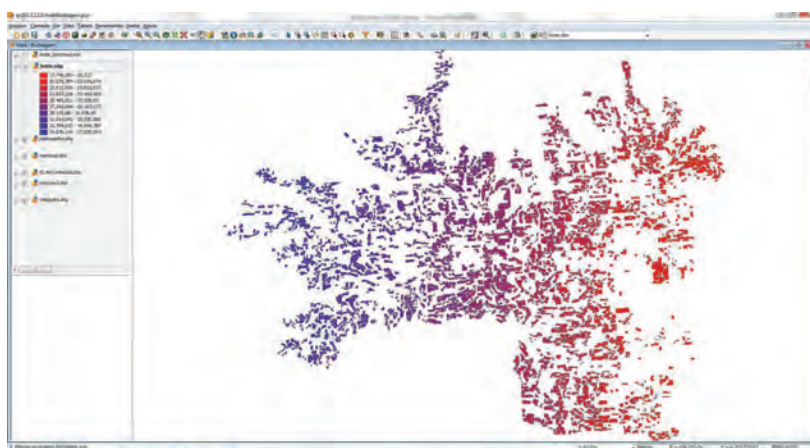


Figure 5. Analysis of the distance from the potential sources of rock powders, departing from the Marrecas dam in Caxias do Sul and going to the GI vineyards in Altos Montes.



Conclusions

The results of this study show the potential of mining waste derived from the gravel industry to be used for soil remineralization, especially in viticulture, which is a traditional crop. Viticulture has been improving its qualifications in the region by using sustainable agricultural practices. Given that all the vineyards in GI Altos Montes are mapped, using GIS made it possible to organize the information of RVSG in order to establish the linear distances from known agromineral sources (quarries, mining waste from gravel industries and dams) to the vineyards.

Having this information made it possible to determine the economic viability of using the rock powder in GI Altos Montes, since the distances measured are less than 50 km. The next step will be to use the road system to identify the routes that show the best economic viability considering the available paths in the region and their respective types (e.g. paved road, unpaved road, etc.).

This study points out to the application of remote sensing techniques in order to find other occurrences of agrominerals. For example, by using multispectral images of medium resolution it is possible to establish relations with the spectra of minerals and rocks measured by spectroradiometry. This information can be helpful in mapping other potential areas of zeolites in order to assist further prospections.

Acknowledgments

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